POLITECNICO DI MILANO

# PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

## THEMATIC Research Field: ADDITIVE MANUFACTURING OF MULTIMATERIALS

| Monthly net income of PhDscholarship (max 36 months) |
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| **1500.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **Motivation and objectives of the research in this field** | Multimaterials offer enhanced performance by combining distinct constituents to achieve tailored mechanical, thermal, or physical properties. When combined with Additive Manufacturing, these materials open up new opportunities for designing multifunctional components. The effective integration of heterogeneous materials requires careful consideration of metallurgical compatibility to ensure the formation of flaw-free interfaces, which are essential for maintaining structural integrity during service. The design of interfaces and suitable heat treatment protocols is critical to enhance bonding, minimize residual stresses, and ensure the long-term reliability of multimaterial systems.<br>The main objectives of the research will be:<br>- To investigate the metallurgical compatibility of heterogeneous material systems by identifying key factors that influence interface integrity and bonding quality, using both CALPHAD-based thermodynamic modeling to determine phase formation and numerical simulations to predict residual stresses and thermal fields.<br>- To produce multimaterial samples starting from raw materials. This includes powder production via atomization, tuning parameters to achieve appropriate particle size and morphology, and printing multimaterial specimens using Laser Powder Bed Fusion (LPBF).<br>- To design and evaluate tailored heat treatment protocols aimed at minimizing residual stresses and improving the overall mechanical and functional properties of heterogeneous systems, using an integrated approach |

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| | that combines computational simulations with PRISMA software and experimental analyses, such as DSC.<br>- To experimentally test the physical and mechanical properties and investigate the microstructure of the fabricated materials. |
| **Methods and techniques that will be developed and used to carry out the research** | The research will combine computational modelling, materials processing, and experimental characterization, including:<br>- Simulation software for predicting phase formation, microstructural evolution, thermal fields and residual stresses.<br>- Powder production by atomization and Additive Manufacturing using LPBF.<br>- Microstructural analysis (OM, SEM, EDS, EBSD, TEM), mechanical testing, and XRD to evaluate material properties. |
| **Educational objectives** | At the end of the PhD program, the candidate will be able to define, design, and carry out original research projects, both independently and as part of a team, or by leading a research group in the field of advanced materials.Opportunities will be offered to undertake visiting research periods hosted by project partners, fostering international scientific collaboration. |
| **Job opportunities** | Job opportunities are expected both in national and international academic institutions, as well as in high-tech companies and SMEs focused on innovation and technological development. Our latest survey on MeccPhD graduates reported a 100% employment rate within the first year and an average salary 35% higher than that of Master of Science holders in the same field. During the PhD, the candidate will collaborate with European companies, universities, and public agencies (e.g., ESA), gaining valuable experience in multidisciplinary and international research environments. |
| **Composition of the research group** | 4 Full Professors<br>2 Associated Professors<br>3 Assistant Professors<br>10 PhD Students |
| **Name of the research directors** | Prof. Riccardo Casati, Prof. Maurizio Vedani |

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| Contacts |
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| Additional support - Financial aid per PhD student per year (gross amount) | |
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| **Housing - Foreign Students** | -- |
| **Housing - Out-of-town residents** | -- |

| Scholarship Increase for a period abroad | |
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| **Amount monthly** | 750.0 € |
| **By number of months** | 6 |

| Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information |
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| Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops, and conferences) for a total amount of €6,114.50.<br>PhD candidates benefiting from this scholarship are required to spend a research period of at least 3 months abroad, joining high-level research groups in their specific research field, as agreed upon with their Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approximately €750/month – net amount). Additionally, candidates who spend at least 3 months abroad are eligible for an extra reimbursement of €3.000 to cover travel expenses.<br>Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities related to teaching support. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations. |